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(71) Applicant: GRUMMAN AEROSPACE CORPORATION [US/US]; 1111 Stewart Avenue, Bethpage, NY 11714-3580 (US).

(72) Inventors: ANDREANO, Richard, J.; 13 Oakledge Drive, E. Northport, NY 11768 (US). HANSEN, Jeffrey, W.; 25 Lace Bark Lane, Medford, NY 11763 (US). KUEHN, Gary, J.; 14 Stephen Lane, Hicksville, NY 11802 (US).

(74) Agents: KENNEY, J., Ernest; Bacon & Thomas, 4th floor, 625 Slaters Lane, Alexandria, VA 22314 (US) et al.

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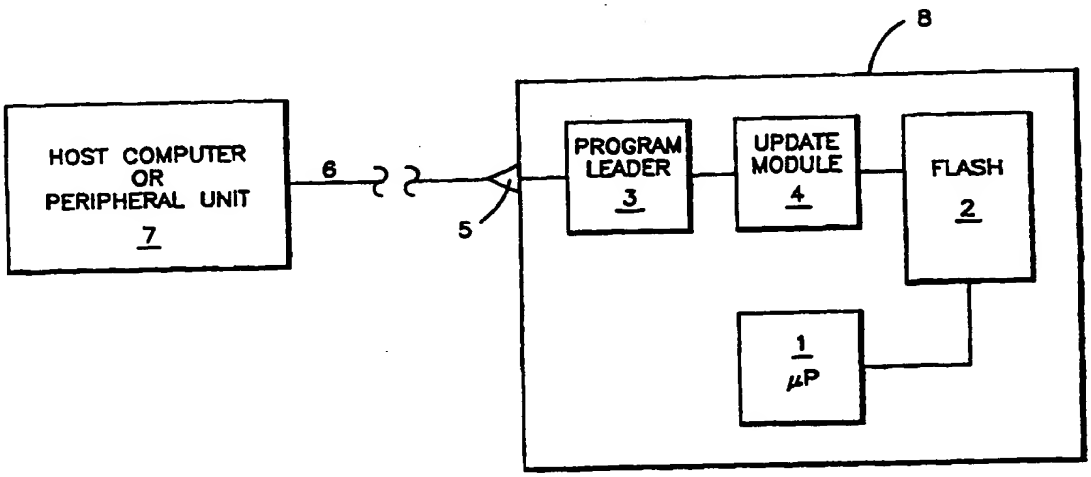

(57) Abstract

A method for programming a microprocessor system (1) embodied within a circuit board (8) adapted for installation into a computer is disclosed. Firmware of the microprocessor system is stored in a flash memory device (2). This firmware is updated with computer programs downloaded into the flash memory from a host computer system (7).

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UPDATING FIRMWARE

BACKGROUND OF THE INVENTION

1. Field of the Invention.

This invention generally relates to microprocessor-based systems, and more particularly to a method for updating the firmware of a microprocessor system which stores its firmware in a programmable memory.

2. Description of the Related Art.

In addition to their use as general purpose computers, microprocessor systems may be designed to perform a dedicated application or to fulfill a specific operational requirement. These systems are usually embodied within

printed circuit cards (also known as boards) adapted for installation into a personal computer (PC), and for this reason have become known as "PC cards." Examples of these types of systems include graphics accelerator boards, emulation boards, self-test diagnostic cards, adapter cards, and frame grabber cards designed to perform a variety of image processing functions.

The "firmware" of a microprocessor system refers to control and application programs stored in a non-volatile memory which are used to drive a microprocessor to perform its dedicated application. As a general rule, microprocessor system firmware will not be altered once fixed in a non-volatile memory by the manufacturer, but there are some exceptions. Firmware must be updated, for example, whenever the microprocessor system is required to perform functions or fulfill requirements different from those originally intended, or to correct errors in the firmware which were not detected at the time of manufacture.

How the firmware of a microprocessor system is updated is a function of the particular type of non-volatile memory used to store the firmware. Conventional microprocessor systems use erasable programmable read only memories (EPROMs) to perform this task.

In order to update the firmware of an EPROM-based microprocessor system, the board embodying the system first must be removed from the personal computer in which it is installed. The EPROM containing the system firmware then must be removed from the board by a skilled technician and either replaced with a new EPROM bearing the updated version of the firmware or subjected to a reprogramming process, which involves erasing the entire contents of the EPROM using ultraviolet light and reprogramming the EPROM using known methods. Finally, the board containing the updated firmware must be reinstalled into the personal computer.

There are a number of drawbacks associated with updating firmware stored in an EPROM. First, the need for a technician to perform the update makes the process a costly and time-consuming endeavor. Second, the updating process is mired with inefficiencies because of limitations inherent in EPROM-type memories. For example, EPROMs have long write times and are unable to be selectively updated. All of these drawbacks make the EPROM less than ideal for storing the firmware of a microprocessor system.

Other systems, such as the one disclosed in U.S. Patent No. 5,210,854 to Beaverton et al., use electrically erasable programmable read only memories (EEPROMs) to store firmware. An EEPROM-type memory is preferable to an EPROM because the former may be updated without requiring a

technician to remove the board. This advantage alone is enough to lower the cost and increase the efficiency of the updating process compared with EPROM-based systems. EEPROMs also can be selectively erased and demonstrate faster write times compared with EPROMs.

Using an EEPROM to store the firmware of a microprocessor system is not without its own drawbacks. The write times of EEPROMs are slow compared with other memory devices. Also, EEPROMs must be supported by independent, on-board power sources which consume board space and add to the cost of employing the system. The need for independent power sources makes EEPROM-based microprocessor systems potentially less reliable than those which utilize non-volatile mass storage devices which can operate off of the power supply of a personal computer.

Another patent, U.S. Patent No. 5,195,130 to Weiss et al., discloses a method for reconfiguring a programmable gate array (PGA) chip to enable a telephone to communicate with a variety of service bureaus. Reconfiguring the PGA is made possible by downloading operating software from a host computer into a FLASH-EPROM in the telephone.

Microprocessor systems are different from PGA-based systems. For example, microprocessor systems can be programmed with appropriate firmware to perform a wide variety of functions. These systems generally are limited

only by the imagination of the firmware designer. In contrast, PGA-based systems are hardware-based devices limited by the number of gates on the PGA chip. These systems therefore can perform comparatively fewer functions than microprocessor systems.

Also, programming a microprocessor system is different from programming a PGA-based system. The type of firmware used to drive a microprocessor system can be varying and diverse. In contrast, the software of a PGA-based system can only be of a type designed to reconfigure the gates of the PGA to perform its limited function, as in the case of the Weiss system where the operating software can only be of a type designed to facilitate communication between the Weiss telephone and the service bureaus.

In view of the drawbacks associated with the methods and systems discussed above, a need exists for a method for programming a microprocessor system to perform a wide variety of functions, and more specifically for a method for updating the firmware of a microprocessor system, which method can be accomplished without having to remove the memory chip containing the firmware from its board and without realizing the disadvantages associated with systems which use conventional programmable memory devices.

SUMMARY OF THE INVENTION

It is a principal objective of the present invention to provide a method for programming a microprocessor system to perform a wide range of functions, which method can be accomplished without having to remove the system from the personal computer in which it is installed, and further without realizing the drawbacks associated with systems that use conventional programmable memories.

It is another objective of the present invention to provide a method for updating the firmware of a microprocessor system which can be accomplished independent of the operating system of the personal computer in which it is installed.

It is another objective of the present invention to provide a method for updating the firmware of a microprocessor system which can be accomplished without requiring any assistance from a skilled technician.

It is another objective of the present invention to provide a PC card which stores firmware in a memory device which does not require removal in order to be updated and which does not realize the disadvantages associated with conventional programmable memories.

The foregoing and other objectives of the invention are achieved by storing the firmware of a microprocessor

system in one or more on-board FLASH memory devices which, because they are able to operate from the power supply of a personal computer, are more economical and reliable to use than conventional non-volatile programmable read-only memory devices. FLASH memory systems are more desirable to use than conventional non-volatile programmable memory systems because they demonstrate faster write times.

A PC card embodying a microprocessor system whose firmware may be updated in accordance with the method of the present invention includes: 1) a microprocessor; 2) at least one FLASH memory chip; 3) a program loader; 4) an update module; and 5) a serial port for enabling the microprocessor to communicate with a peripheral unit.

A preferred embodiment of the method of the present invention involves: interrogating an on-board serial data port for the presence of a signal from a host computer; shifting control of an on-board program loader and update module to the host computer when such a signal is detected; downloading one or more computer programs from the host computer into the program loader; and updating, under the control of the update module, the firmware stored in the FLASH memories with the computer programs stored in the program loader.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a diagram of a microprocessor board which includes at least one FLASH memory chip containing firmware which may be updated in accordance with the method of the present invention.

Figure 2 is a flow diagram detailing steps included within the method of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is a method for programming the firmware of a microprocessor system which may be embodied within a PC card adapted for installation into embedded or industry standard architectures such as ISA, VME, or VXI.

The PC card preferably has a generic card configuration design including holes, rail guides, optional card ejectors, and a card connector which is either the right-angle or straight-pin-and-socket type. The card connector also may be of a type which permits the PC card to reside in a bucket-and-motherboard environment, card stackable environment, or a stand-alone environment.

Referring to Figure 1, the PC card 8 includes an on-board microprocessor 1, at least one FLASH memory chip 2, a program loader 3, an update module 4, and a set of terminals (not shown) for communicating with other PC cards. The card may also be equipped with at least one

serial port 5 which enables it to communicate with a peripheral unit 7 through an RS-232 interface 6. The use of an RS-232 channel advantageously allows the PC card to communicate with different types of peripherals independent of the operating system of the computer. As will be explained, the peripheral may be a host computer system such as a Sun microcomputer, a VAX, or a personal computer.

Firmware for the microprocessor system is stored within the FLASH memory and may include application programs as well as any microprogram governing the internal control of the microprocessor system, such as the Basic Input/Output System (BIOS) of the microprocessor. The application and control programs stored in FLASH memory determine the specific functions and applications the card will perform. The PC card, for example, may be programmed to serve as a processing unit for an avionic bus analyzer, a controller for portable maintenance aids for aircraft and other vehicles, a memory loader verifier, and a primary controller for all new organizational level test sets.

A preferred embodiment of the method of the present invention is carried out in accordance with a special control program stored in a portion of the FLASH memory which may or may not be subject to modification. Referring to Figure 2, under the control of this program, the microprocessor, upon system initialization (i.e., when power is applied to the PC card), interrogates the RS-232

scenarios that heavily burden ISA architectures real-time capabilities. Static random access memory (SRAM) may also be supported.

Specific uses for the method of the present invention are contemplated. For example, the present method may be used to update the firmware of a PC card installed in a stand-alone, rugged personal computer. (For purposes of this specification, a rugged personal computer is a microcomputer in its most basic form. It consists of the minimum amount of hardware and software required to retain the capability of a personal computer. Rugged personal computer systems, for example, may contain only the motherboard of a personal computer and any PC boards which may be added onto the motherboard. No housing, hard drives, hard disks, or display monitors are included.)

Rugged personal computer systems may be employed, for example, in an avionics system of a fighter aircraft. A PC card containing firmware stored in a FLASH memory may be installed in the rugged personal computer to perform a dedicated application. The method of the present invention then could be used to update the firmware of the PC card to enable the card to communicate with the variety of sub-systems in the avionics system. For example, the PC card could initially be loaded with firmware which would permit it to run a diagnostic program to test an electronics countermeasure sub-system of the aircraft. A host computer

may then be used to download new firmware into the FLASH memory which would allow for testing of an engine monitoring sub-system. Used in this fashion, the FLASH memory of the PC card emulates a hard disk for the rugged personal computer.

Uses of the method of the present invention also include stand-alone embedded applications such as portable data loggers, memory loader verifiers, and avionic bus monitors for use in and around aircraft.

Other modifications and variations to the invention will be apparent to those skilled in the art from the foregoing disclosure. Thus, while only certain embodiments of the invention have been specifically described herein, it will be apparent that numerous modifications may be made thereto without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A method for programming a microprocessor system to perform at least one predetermined function, said system being embodied within a circuit board having a communication means attached thereto for communicating with a peripheral unit, said method comprising the steps of:

providing at least one FLASH memory device on said circuit board containing firmware of the microprocessor system;

interrogating the communication means for the presence of a signal from said peripheral unit when the system is initialized; and

receiving a computer program through said communication means from said peripheral unit when said signal is detected, said computer program replacing at least a portion of the firmware stored in said at least one FLASH memory to cause said system to perform said function.

2. The method recited in claim 1, further comprising the steps of:

providing a memory on said board for receiving the computer program from the peripheral unit when said signal is detected by the microprocessor; and

providing an update module for erasing at least a portion of the firmware contained in said at least one FLASH memory and writing in its place the computer program in said memory.

3. The method recited in claim 1, wherein said circuit board is adapted for installation into a personal computer having an ISA architecture.

4. The method recited in claim 3, wherein programming of the microprocessor system occurs independent of an operating system of the computer.

5. The method recited in claim 3, wherein programming of the microprocessor system is accomplished while said circuit board remains installed in an end item configuration.

6. The method recited in claim 1, wherein said circuit board embodying the microprocessor system is adapted for installation into a stand-alone, rugged computer.

7. The method recited in claim 1, wherein said circuit board embodying the microprocessor system is adapted for installation into a stand-alone embedded system.

8. The method recited in claim 1, wherein said communication means includes a serial port coupled to an RS-232 interface.

9. The method recited in claim 1, wherein said peripheral unit is a host computer system.

10. The method recited in claim 1, wherein said computer program is a built-in-test program having diagnostic control.

11. The method recited in claim 1, wherein said computer program enables said system to operate as a processing unit for an avionic bus analyzer.

12. The method recited in claim 1, wherein said computer program is BIOS firmware.

13. The method recited in claim 1, wherein said circuit board includes a microprocessor having built-in power management control.

14. The method recited in claim 3, wherein said circuit board includes a connecting means for connecting said board to a motherboard of said personal computer.

15. The method recited in claim 3, wherein said circuit board includes a connecting means for connecting said board to other PC cards in a card-stackable fashion.

16. In a microprocessor system of the type which is embodied within a circuit board adapted for installation into a computer, said circuit board having a port affixed thereto for communicating with a host computer, wherein the improvement comprises:

at least one FLASH memory on said circuit board for storing firmware of the microprocessor system, said firmware being updated with a computer program downloaded from said host computer when a signal indicating the presence of the host computer is detected by said system.

17. The system recited in claim 16, further comprising:

a buffer for storing the computer program received from said host computer; and

an update module for rewriting selected portions of the firmware in said at least one FLASH memory with the computer program stored in said buffer.

18. The system recited in claim 16, wherein the firmware update occurs independent of an operating system of the computer.

19. The system recited in claim 16, wherein said firmware update occurs while said circuit board remains installed in an end item configuration in said computer.

20. The system recited in claim 16, wherein said computer system is a stand-alone, rugged computer.

21. The system recited in claim 16, wherein said computer is an embedded computer.

22. The system recited in claim 16, wherein said port is a serial port coupled to an RS-232 interface.

23. The system recited in claim 16, wherein said computer program is a built-in-test program having diagnostic control.

24. The system recited in claim 16, wherein said computer program enables said system to operate as a processing unit for an avionic bus analyzer.

25. The system recited in claim 16, wherein said computer program is BIOS firmware.

26. The system recited in claim 16, wherein said circuit board includes a microprocessor having built-in power management control.

27. The system recited in claim 16, wherein said circuit board includes a connecting means for connecting said board to a motherboard of said personal computer in a card-stackable fashion.

28. The system recited in claim 16, wherein said circuit board includes a connecting means for connecting said board to other PC cards in a card-stackable fashion.

29. A PC card adapted for installation into a computer, said card comprising:

a microprocessor;

a port in communication with a peripheral unit;

a buffer memory in communication with said port;

at least one FLASH memory device for storing firmware for driving said microprocessor to perform a predetermined function, said firmware being updated with a computer program downloaded into said buffer memory from said peripheral unit when a signal sent by the peripheral unit is detected by the microprocessor through said port, said update occurring independent of an operating system of said computer.

30. A PC card as recited in claim 29, further comprising:

an update module for rewriting the firmware stored in said at least one FLASH memory with the computer program stored in said buffer memory.

31. The PC card recited in claim 29, wherein the firmware update is accomplished while the card is installed in the computer in an end item configuration.

32. The PC card recited in claim 29, wherein said computer is a stand-alone, rugged personal computer.

33. The PC card recited in claim 29, wherein said computer is an embedded computer.

34. The PC card recited in claim 29, wherein said port is a serial port coupled to an RS-232 interface.

35. The PC card recited in claim 29, wherein said peripheral unit is a host computer system.

36. The PC card recited in claim 29, wherein said computer program is a built-in-test program having diagnostic control.

37. The PC card recited in claim 29, wherein said predetermined function is to serve as a processing unit for an avionic bus analyzer.

38. The PC card recited in claim 29, wherein said computer program is BIOS firmware.

39. The PC card recited in claim 29, wherein said microprocessor has a built-in power management control which may be extended to on-board and off-board peripherals.

40. The PC card recited in claim 29, further comprising:

a connecting means for connecting said board to a motherboard of said personal computer.

41. The PC card recited in claim 29, further comprising a connecting means for connecting said board to other PC cards in a card stackable fashion.

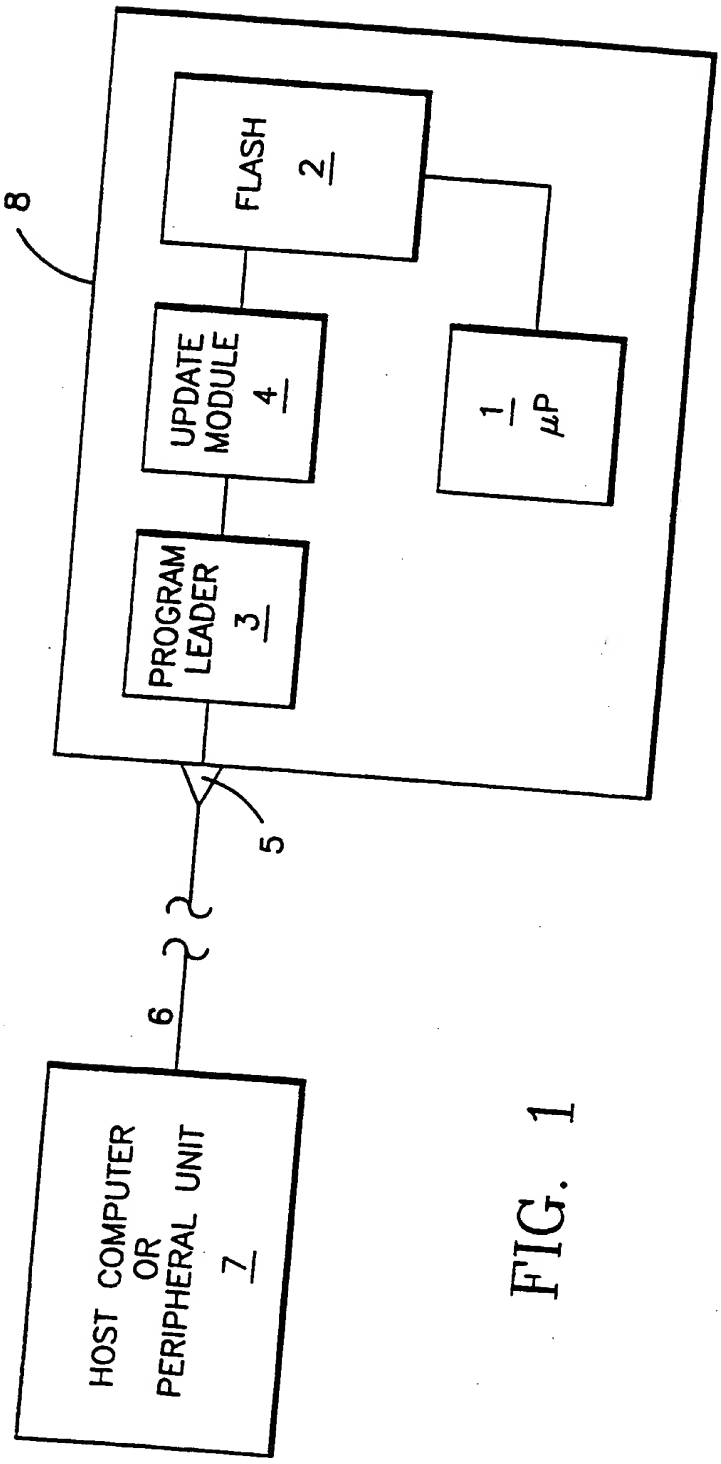
8
FLASH
2
UPDATE
MODULE
4
1
μP
PROGRAM
LEADER
3
5
6
HOST COMPUTER
OR
PERIPHERAL UNIT
7

FIG. 1

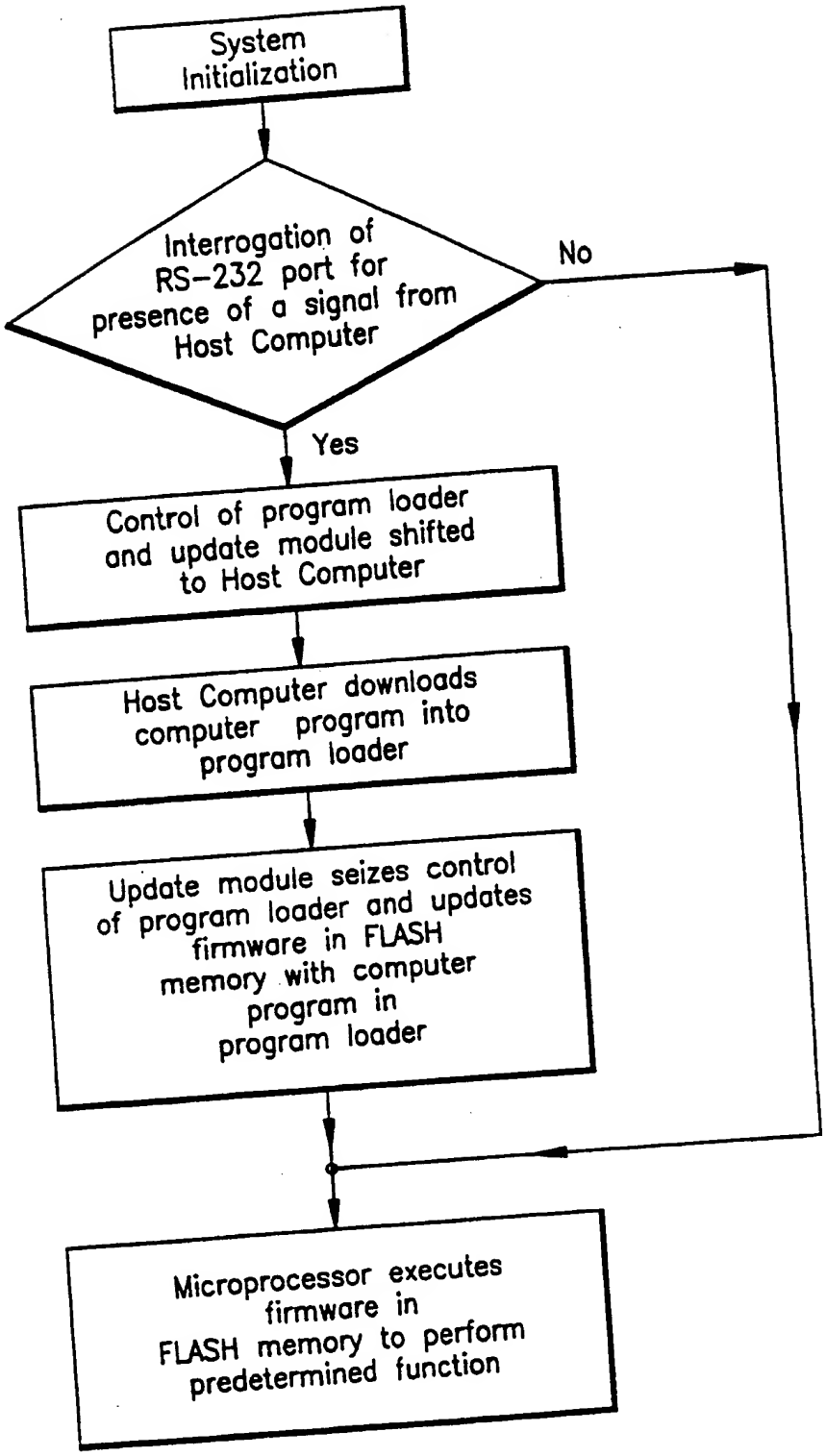
System Initialization
Interrogation of RS-232 port for presence of a signal from Host Computer
No
Yes
Control of program loader and update module shifted to Host Computer
Host Computer downloads computer program into program loader
Update module seizes control of program loader and updates firmware in FLASH memory with computer program in program loader
Microprocessor executes firmware in FLASH memory to perform predetermined function

FIG. 2

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER IPC(6) :G06F 9/06 US CL :395/700 According to International Patent Classification (IPC) or to both national classification and IPC	International application No. PCT/US95/07872
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) U.S. : 395/700	
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched	
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) APS, STN	

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 5,321,840 (AHLIN ET AL) 14 JUNE 1994. SEE THE ABSTRACT AND COL. 10-COL. 12.	1-41

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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